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# Unit VI: Heat Review

1) Explain the kinetic molecular theory.

See notes

2) What is the difference between temperature and thermal energy?

Thermal energy → total kinetic and potential energy Temperature → average energy

3) What is heat?

-thermal energy transferred from one object to another

4) Convert 37 °C to K.

37 °C + 273 = 310 K

5) Convert 215 K to °C.

215 − 273 = −58 °C

6) What is the change in the length of a 15.0 m steel rail as it is cooled from 1535°C to 20°C? (-0.27 m)

$\Delta L = ?$
$L_0 = 15.0 m$
$T_i = 1535 °C$
$T_f = 20 °C$
$\alpha = 12 \times 10^{-6} °C^{-1}$

$\Delta L = \alpha L_0 \Delta T$

$\Delta L = 12 \times 10^{-6} °C^{-1} (15.0 m)(20 °C - 1535 °C)$

$\Delta L \approx -0.27 m$

7) A metal rod has a length of 100. cm at 200.°C. At what temperature will the length be 99.6 cm if the coefficient of linear expansion of the material in the rod is 2.0 x $10^{-5}$ °$C^{-1}$? (0 °C)

$L_0 = 100. cm$
$T_i = 200. °C$
$L_f = 99.6 cm$
$T_f = ?$
$\alpha = 2.0 \times 10^{-5} °C^{-1}$

$\Delta L = \alpha L_0 \Delta T$
$\Delta L = \alpha L_0 (T_f - T_i)$
$\frac{\Delta L}{\alpha L_0} = T_f - T_i$
$\frac{\Delta L}{\alpha L_0} + T_i = T_f$

$T_f = \frac{(99.6 cm - 100. cm)}{(2.0 \times 10^{-5} °C^{-1})(100. cm)} + 200 °C$

$T_f = 0.00 °C$

8) A 2.00 L aluminum container at 35.0°C heats up to 100.0°C. What is the change in volume the container experiences? (9.8 x $10^{-3}$ L)

$\Delta V = ?$
$V_0 = 2.00 L$
$T_i = 35.0 °C$
$T_f = 100.0 °C$
$\beta = 0.75 \times 10^{-4} °C^{-1}$

$\Delta V = \beta V_0 \Delta T$

$\Delta V = 0.75 \times 10^{-4} °C^{-1} (2.00 L)(100.0 °C - 35.0 °C)$

$\Delta V = 9.8 \times 10^{-3} L$

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9) How much would the volume of 4.00 L of gasoline change if the temperature increased from –40.0°C to 318 K? (0.17 L)

$\Delta V = ?$
$V_o = 4.00 L$
$T_i = -40.0°C = 233 K$
$T_f = 318 K$
$\beta = 4.9 \times 10^{-4} °C^{-1}$

$\Delta V = \beta V_o \Delta T$

$\Delta V = 4.9 \times 10^{-4} °C^{-1} (4.00 L)(318 K - 233 K)$

$\Delta V \approx 0.17 L$

10) In kJ, how much heat is required to raise the temperature of 1.23 kg of water from 23.6 °C to 84.9 °C? (317 kJ)

$Q = ?$
$m = 1.23 Kg$
$c = 4200 J/Kg°C$
$T_i = 23.6°C$
$T_f = 84.9°C$

$Q = mc\Delta T$

$Q = 1.23 Kg (4200 J/Kg°C)(84.9°C - 23.6°C)$

$Q = 316675.8 J$

$Q \approx 317 KJ$

11) 24 000 J of heat is released when 640 g of silver drops in temperature. If the silver was initially at -10.0 °C, what is the final temperature of the silver? (-170 °C)

$Q = -24000 J$
$m = 640 g = 0.640 Kg$
$T_i = -10.0°C$
$T_f = ?$
$c = 230 J/Kg°C$

$Q = mc(T_f - T_i)$

$\frac{Q}{mc} = T_f - T_i$

$\frac{Q}{mc} + T_i = T_f$

$\frac{-24000 J}{0.640 Kg (230 J/Kg°C)} + (-10.0°C) = T_f$

$-170°C \approx T_f$

12) 5.00 x 10$^2$ J of heat produces a temperature increase of 8.77 K in a 95 g sample of an unknown substance. What is the specific heat capacity? What is the substance? (6.00 x 10$^2$ J/kg°C, Glass)

$Q = 5.00 \times 10^2 J$
$\Delta T = 8.77 K$
$m = 95 g = 0.095 Kg$
$c = ?$

$Q = mc\Delta T$

$\frac{Q}{m\Delta T} = c$

$\frac{5.00 \times 10^2 J}{0.095 Kg (8.77 K)} = c$

$6.00 \times 10^2 J/Kg°C \approx c$

Glass

13) A piece of aluminum at 14.0 °C is dropped into 5.00 kg of antifreeze at 53.0 °C. If the final temperature of the mixture is 308 K, find the mass of the aluminum. (10.5 kg)

$M_a = ?$
$C_a = 900 J/Kg°C$
$T_{ia} = 14.0°C$
$M_f = 5.00 Kg$
$C_f = 2200 J/Kg°C$
$T_{if} = 53.0°C$
$T_f = 308 K = 35°C$

$Q_a = -Q_f$

$M_a C_a \Delta T_a = -M_f C_f \Delta T_f$

$M_a = \frac{-M_f C_f T_f}{C_a \Delta T_a}$

$M_a = \frac{-5.00 Kg (2200 J/Kg°C)(35.0°C - 53.0°C)}{900 J/Kg°C (35.0°C - 14.0°C)}$

$M_a \approx 10.5 Kg$

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14) When 10.0 kg of antifreeze at 20.0 °C is added to 1.50 kg of water at 85.0 °C, what is the final temperature of the mixture? (34.5 °C)

$T_f = ?$
$m_a = 10.0\,Kg$
$T_{ia} = 20.0\,°C$
$C_a = 2200\,J/Kg\,°C$
$m_w = 1.50\,Kg$
$T_{iw} = 85.0\,°C$
$C_w = 4200\,J/Kg\,°C$

$Q_a = -Q_w$

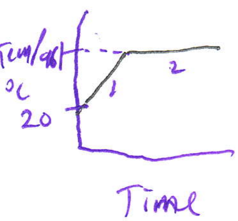
$m_a C_a (T_f - T_{ia}) = -m_w C_w (T_f - T_{iw})$

$$T_f = \frac{m_w C_w T_{iw} + m_a C_a T_{ia}}{m_a C_a + m_w C_w}$$

$$T_f = \frac{1.50\,Kg(4200\,J/Kg\,°C)(85.0\,°C) + 10.0\,Kg(2200\,J/Kg\,°C)(20.0\,°C)}{10.0\,Kg(2200\,J/Kg\,°C) + 1.50\,Kg(4200\,J/Kg\,°C)}$$

$T_f \simeq 34.5\,°C$

15) How much heat is needed to turn 2.0 kg of silver at 20 °C into a liquid? Silver melts at 961 °C. (450 KJ)




(1) $Q = mc\Delta T$

$Q = 2.0\,Kg(230\,J/Kg\,°C)(961\,°C - 20\,°C)$

$Q = 432860\,J$

$Q \simeq 430\,KJ$

(2) $Q_f = H_f m$

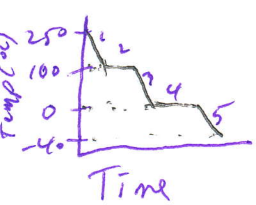
$Q_f = 10.4\,KJ/Kg(2.0\,Kg)$

$Q_f = 20.8\,KJ$

$Q_f \simeq 21\,KJ$

$Q_{Total} = 430\,KJ + 21\,KJ \simeq 450\,KJ$

16) How much heat is released when 500 g of steam at 250 °C is cooled to form ice at -40 °C? (-1700 KJ)




(1) $Q = mc\Delta T$

$Q = 0.5\,Kg(2000\,J/Kg\,°C)(100\,°C - 250\,°C)$

$Q = -150\,KJ$

(2) $Q_v = m H_v$

$Q_v = 0.5\,Kg(-2260\,KJ/Kg)$

$Q_v \simeq -1130\,KJ$

(3) $Q = mc\Delta T$

$Q = 0.5\,Kg(4200\,J/Kg\,°C)(0\,°C - 100\,°C)$

$Q \simeq -210\,KJ$

(4) $Q_f = m H_f$

$Q_f = -0.5\,Kg(334\,KJ/Kg)$

$Q_f = -167\,KJ$

(5) $Q = mc\Delta T$

$Q = 0.5\,Kg(2100\,J/Kg\,°C)(-40\,°C - 0\,°C)$

$Q = -42\,KJ$

$Q_{total} = -150\,KJ - 1130\,KJ - 210\,KJ - 167\,KJ - 42\,KJ \simeq -1700\,KJ$

17) Be sure to have completed the thermodynamics reading assignment. Look over the questions.

Done.